# SCIENCE:

## A Weekly Record of Scientific Progress.

**JOHN MICHELS, Editor.**

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### NOTICE TO SUBSCRIBERS.

We consider it due to those subscribers who have favored us with their subscriptions, previous to the publication of our club rates, that they should have the privileges of the list. They can therefore send us subscriptions for any or all of the publications named at the reduced double rates, less $4, the subscription price of "Science."

Since the publication of the club rates last week, we have received rates from the proprietor of *The American Journal of Science and Arts*, the terms of which are $6 a year. The club rate with Science will be $8.50 per annum.

The material aid given to scientific students by the foundation of twenty fellowships, each yielding five hundred dollars, at the Johns Hopkins University, appears to have been attended with the best results, and the roll of fellows, now published, shows that the honor, thus secured, has not been a mere empty title, for the majority have been selected to receive permanent and attractive posts in different parts of the country.

The system of fellowships at this University was instituted for the purpose of affording to young men of talent, from any place, an opportunity to continue their studies in the Johns Hopkins University, while looking forward to positions as professors, teachers, and investigators, or to other literary and scientific vocations.

The appointments have not been made as rewards for good work already done, but as aids and encouragement to good work in the future, thus stimulating the student to further progress, and becoming the stepping stone to an honorable, intellectual career. Although candidates for any of the three learned professions are not excluded, the preference is given to those young men who are desirous of becoming teachers of science and literature, or who have determined to devote their lives to special branches of learning which lie outside of the ordinary studies of the lawyer, the physician, and the minister.

As an introduction, the candidate must submit his college diploma, or other certificate of proficiency from the institution where he received instruction, with recommendation from those who are qualified to speak of his character and attainments. He is also expected to submit, orally or in writing, evidence of his past success in study, and of his plans for the future, together with samples of his literary or scientific work. Thus the examination is in a certain extent competitive, but not with uniform tests, nor by formal questions and answers submitted to the candidate.

We find that the number of candidates has been very large, and it is feared many were rejected whose acquirements were really superior to those selected. We are informed by the authorities of the University that such a result may arise in cases where candidates rely wholly on testimonials from their teachers, without presenting such evidences of their own work as we have stated to be essential; and in consequence the professors, for want of adequate knowledge, have been compelled to pass over many candidates whose merits were undoubtedly of a high order.

We mention these facts, and trust that in the next year the warning we now give may prevent many disappointments. Candidates should also notice that applications should be made prior to May 13, 1881.

As evidence of the value of securing such a fellowship, we may state, that of the forty-six students who have left the University with that honor, twenty-eight have gone forward to honorable positions, as instructors in colleges or other institutions of a high order; two were attached to the United States Coast survey; two, to the Metropolitan Museum of Art, at New York; four are engaged in the application of science to practical work; two are physicians, one an attorney-at-law, and four are still pursuing their studies abroad.

It is obvious that graduates residing at Baltimore have great facilities for making known their powers to the appointing board, but an examination of the list of those who have been successful, shows that residence at a distance is no bar to the appointment, provided adequate evidence of claims be presented.

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The Smithsonian Institution has received from the Vienna Academy the announcement of the discovery, by M. Pennule, at Copenhagen, on the 16th of December, 1880, at six o'clock, of a small bright comet in 18 hours 49 minutes right ascension and 10 degrees 30 minutes north declination, with a daily motion of 5 minutes in right ascension and 40 minutes north.

Washington, December 17, 1880.

## ON THE SUPERFICIAL VISCIDITY OF LIQUIDS.

Translated for "SCIENCE" from the French of J. Plateau,

By THE MARCHIONESS CLARA LANZA.

In the year 1638 Descartes affirmed that the surface of water presented a resisting tendency as though it were covered with a thin pelicle. Several other learned men have asserted the same fact and sought to verify it by various experiments. Some limited their researches to water alone; others maintained that the tests were applicable to all liquids. In my own observations I have described experiments and facts which, in my opinion, at once remove all doubt as to the reality of a peculiar resisting force manifested by the surface of water, solutions, etc., and I have attributed this resistance to a characteristic viscidity or glutinous matter pertaining exclusively to the outer coating of these liquids. Nevertheless, I have demonstrated that certain other fluids are totally exempt from this peculiarity, and I hope I have fully established the fact, heretofore, that in several among them, such as alcohol, spirits of turpentine, sulphuric ether, etc., the invisible particles of the outer layer offer, on the contrary, less resistance in regard to relative displacement than those within the mass.

Permit me to recall the facts of which my principal experiments consist. A magnetized needle is placed upon a pivot in the centre of a glass cylinder; the liquid to be tested is then poured into the vessel—just enough to come in contact with the needle; the latter is then turned to a meridian of about 90°, then in a few moments is left to itself, and the time which it takes to travel over a determined angle must be correctly ascertained. In my experiments the angle was 85°. More liquid must then be introduced into the cylinder so that the needle is completely covered, the liquid rising at least two-thirds of an inch above it. The needle is then again turned to a meridian of 90°, and one must remark the time taken to describe the preceding angle. Now, for example, when the liquid is distilled water, my needle took precisely twice as long when upon the surface as when beneath it, notwithstanding that in the first case the under surface of the needle alone came in contact with the water, while in the latter it was completely immersed. When the liquid employed was alcohol or turpentine the time required by the needle, when upon the surface, was less by half than when beneath it.

I must add that in those liquids on whose surface the magnet moves more slowly than when beneath it, the entire outer coating moves also, although somewhat less rapidly.

Two liquids, one a solution of albumen and the other of a saponaceous consistency, have exhibited superficial viscidity in an extremely forcible manner. After having moved with the utmost slowness, the needle stopped at an angle of 35° on the surface of the former. It did not move at all upon the latter liquid.

I omit purposely the various details relative to those experiments, as well as other facts belonging to the subject in question. I shall mention them further on as the reasons present themselves, and at this time merely confine myself to the special object of these remarks, that is to say, the cause and nature of these phenomena.

In a notice published in 1870, M. Luvini expressed doubt in regard to the superficial viscidity of liquid matter[1]. He presumes that the effects I myself have observed are due to some alteration in the outer surface caused by the contact of the liquid with the air, or else by particles of dust floating about.

In 1872 M. Marangoni published a paper,[2] in which he seeks to prove that the viscidity upon the outer portion of the liquid is identical with that which is beneath the surface. According to him, in such liquids as water, for instance, which does not produce bubbles, the resistance is increased by a capillary action exercised by the glass upon the needle; while, when liquids which bubble easily are used, the resistance springs from a thin cuticle in coating of a nature peculiar to the liquid itself.

I replied to both these articles[3]; but M. Marangoni attacked me again last year[4]. In his second work he substitutes, for some unknown reason, *particles of dirt* for the word cuticle. When speaking of the saponaceous solution, he states that the carbonic acid in the air decomposes the soap and produces an alkaline carbonate which removes the fatty acids and forms a kind of emulsion upon the surface. As to the solutions of albumen he thinks probably that the coating of dust is produced by the evaporation of the water.

He does not positively deny that the surface of liquids cannot possess a viscidity of its own apart from that which is in the mass; but he is persuaded that the influence of the viscidity peculiar to the surface is very small indeed when compared with that which effects the final results. The following is the substance of his theory:

We all know that if we place upon any liquid a drop of another possessing less external elasticity, the drop will spread itself in a thin coating upon the surface of the former. Consequently, when a liquid is covered with a layer of dirt, we may reasonably admit that this layer possesses an elastic force much inferior to that which belongs to the pure, fresh surface of the underlying liquid. Now proper experiments show us, first of all, that the tension of this coating is effectively much less forcible than that of the liquid beneath; secondly, that if the coating becomes sufficiently thick, the elasticity disappears entirely, or very nearly; thirdly, that in any saponaceous solution the film can be accumulated upon certain portions of the surface and removed upon others.

When a bubble is blown from one of these liquids the layer of dirt extends in both sides of it and thus prevents its breaking. Liquids such as alcohol, ether, turpentine, etc., cannot, owing to the slight elastic force they possess, be covered with a coating of dirt, and for this reason they are unable to produce bubbles.

The retarded movement of the needle upon the surface of the liquid does not arise from any viscidity of the outer layer, for, in the saponaceous solution at least, this coating is very movable, as the two following facts will show:

In the first place, when a large soap bubble is blown, reflecting various colors, the slightest breath of air will cause it to whirl rapidly backwards and forwards. In the second place, if a certain amount of soap-suds be put into a horizontal brass tube sufficiently large for the purpose, and a magnet be placed inside upon a pivot, directed toward the magnetic meridian, and then left to oscillate at will, you will perceive that the vibrations are very nearly as rapid as when the magnet moves freely in the air, notwithstanding the fact that it has to overcome the resistance offered by the two outer coatings of the liquid.

When a coating of dirt exists, the somewhat retarded motion of the magnet upon the surface, together with the rotating movement of the entire mass, can be explained in the following manner: The magnet itself tends to remove the dirt which is behind it and accumulate it all in front; this produces an excess of elasticity along the posterior contour, directly opposed to the natural motion, and at the same time a diminutive expansive force along the anterior contour. Furthermore, behind each half of the magnet, the superfluity of expansive force on the fresh surface draws together the edges of that portion which is already freed from dirt as though to close the rent, and, at the same time, as in each of the anterior parts, the portions far removed from the edge of the magnet possess a weaker expansive force than those nearer to it; the former attract the latter and thus determine the rotation of the entire mass.

[1] *Alcune sperienze considerazioni intorno all' adesione tra solidi e liquidi.* Turin, 1870.

[2] *Sul principio della viscosita superficiale dei liquidi stabilito dal Signor J. Plateau.*

[3] *Réponse aux objections de M. Marangoni contre le principe de la viscosité superficiale des liquides.*

[4] *Difesa della teorica dell' elasticita superficiale dei liquidi.* 1878.

If the outer layer of the liquid should resist the movement of the magnet from any viscosity of its own, it would pucker perceptibly; moreover, viscous bodies propagate motion with difficulty from any distance.

The coating of dirt imitates closely an elastic body, inasmuch as it tends to return to its primitive state when broken; however, it substitutes, in place of superficial vsicosity, *superficial elasticity.*

In regard to those liquids of strong expansive force which do not produce bubbles, such as water, the greater portion of briny solutions, etc., liquids upon whose surface a layer of dirt cannot easily be attested, the retarded movement of the magnet upon the exterior is hardly due to the changes which occur in the cavities of the meniscus, terminating the magnet at each end, partly, also, to the beginning of a layer of dirt, M. Hagen having discovered that the surface of water undergoes modifications by exposing the liquid to the air. But the principal cause may reasonably be said to be the fact which M. Van der Mengsburgghe has so well described, namely, that when the surface of any liquid is augmented, or, in other words, when any diffusion of the pure exterior takes place, a sudden cooling, followed by an increased tension, ensues, and, reciprocally, a warmth and decrease of tension correspond to any diminution or contraction of the surface.

This then is the main substance of the theory proposed by M. Marangoni in compensation for mine. Let us endeavor to examine it. First of all, it would seem, according to his doctrine, that it is merely necessary to add to any liquid of strong expansive force which does not bubble, a drop of another liquid of weak tension in order to produce large bubbles from the former. Now if a drop of olive oil or spirits of turpentine be placed upon distilled water, the liquid will rebel strongly against the formation of bubbles. Should the water be covered with a thin coating of either of the above mentioned liquids, you will find that it bursts in the bowl of the pipe before you have even commenced to blow the bubble. We must admit therefore, in the first place, that the supposed coating of dirt must have close connection with the liquid beneath it. The author also assigns an additional and indispensible cause for the production of bubbles which he describes as the *superficial elasticity*, or in other words, the facility with which the dirt spreads itself over the liquid, so that the latter is always covered. Nothing however, goes to show us that a thin coating of olive oil or turpentine does not possess the same elasticity.

The author, in fact, describes two circumstances in which foreign substances produce a coating upon distilled water which is more or less effectual. First of all, if the pollen of flowers is spread upon the surface and air blown from above within an hour or two, the little apertures formed will remain for a long time; but the liquid refuses to form bubbles when blown from a pipe or tube. In the second place, they can be produced, nevertheless, by means of pure distilled water, if the tube is partially filled with small particles of camphor. The diameter of these bubbles may reach an inch and more. But we can readily see that these facts are only the beginning of success. However, they are in no wise opposed to the theory of superficial viscidity, since in both cases the outer layer of the water undergoes modifications.

According to the author, the superficial elasticity is estimated by the difference which exists between the tension of the pure surface and that of the dirty surface, and he determines this by means of a small apparatus which he calls a *capillary balance*. In his opinion, as we have already seen, when a bubble is blown the coating of dirt prevents its being broken. In his statement he gives no reason for this but in a preceding work he explains himself clearly on this point. He says that if the coating of dirt should become disunited, the excess of tension upon the under layer, or in other words, the superficial elasticity, would instantly close the aperture. Hence the facility for the formation of bubbles, or as the author calls it, the pompholygenic power, should decrease with the superficial elasticity. Now M. Marangoni is led to the conclusion that all causes which tend to diminish this elasticity without removing the dirt, render the development of bubbles much easier. Further on, he returns to this proposition and says that "all those conditions which diminish this elasticity to the advantage of the plasticity increase the pompholygenic force." If we examine closely his ideas, we can understand that an increase of plasticity favors considerably the generation of bubbles; but how is it possible that a diminution of elasticity can lead to the same result?

Let us return to the first of the two facts quoted above. The author finds, by means of his capillary balance, that the superfine elasticity of the distilled water, covered with pollen, may become doubly as great as that found in the saponaceous solution. Now, inasmuch as the latter produces large bubbles while the former gives none at all, it is necessary, according to M. Marangoni's proposition that the plasticity of the saponaceous solution should be much superior to that of the distilled water, which is rather difficult to admit owing to the peculiar rigidity of the surface of the former; indeed there are two totally different liquids in question; nevertheless, the author's statement seems to apply equally to both in this case.

In order to show that the layer of dirt can be accumulated upon one portion of the surface of a liquid and diminished upon another, M. Marangoni describes the the following curious experiment.

He plunges, into a soapy solution, a ring made of iron wire about seven and a half inches in diameter and fastened to the end of a fork which serves as a handle; when the ring is immersed he draws it out again, holding it in a horizontal position; he then raises it until the catenoid wave, which unites it to the surface of the liquid, separates into two portions, one of which forms an even layer within the ring, while the other produces a spherical cavity upon the liquid; now, if the temperature is low enough (from 12 to 14 degrees), this cavity is very hollow, the radius of the base measuring 48 *millimetres*, while the height is only 27. M. Marangoni began this experiment four times, always breaking the cavity before again immersing the ring, and by this means he obtained the maximum of depression in which the depth was exactly half of the radius of the base. While the ring is being raised the circumference, in accordance with which the catenoid lamina unites with the surface of the liquid, contracts, and as M. Marangoni affirms, condenses the coating of dirt on the interior and dilates it on the exterior. Hence, when the cavity is once formed a diminution of tension takes place in the space limited by its base, and an increase of tension occurs on the outside; this excess of tension consequently aids the basis of the cavity to enlarge, and results in the depth being diminished.

According to my theory, the superficial layer of the liquid contracts, as above stated, on the interior of the opening, and dilates on the exterior; but its consistency does not undergo any modification. The portion which contracts forces a part of its molecules into the mass beneath, and the dilated portions attract these atoms. Now, according to M. Van der Mensbrugghe's theory which I have mentioned already, these effects cannot be produced unless a diminution of tension takes place within the contracted portion and an augmentation of the same in the dilated part. This phenomenon, however, can only occur in a very low temperature, and when, in consequence, the cavities manifest a certain viscidity. When the temperature is notably higher the cavities are smaller and their depression less. At 26 degrees hardly any effect is visible. The radius of the base at this temperature was 23 *millemetres*, and the height 20; but I have shown that all cavities formed upon the surface of

liquids are never complete hemispheres. M. Marangoni thinks it probable, as I have said before, that the coating of dirt on the saponaceous solution is due to the action of carbonic acid contained in the air.

I have ascertained that carbonic acid actually decomposes the solution inasmuch as it removes all fatty acids; but does the formation of the layer really arise from this cause? In order to discover this the following experiment has been made:

A certain amount of a concentrated solution of caustic potash was placed within a bottle holding almost a quart, then, after tightly corking the latter it was violently shaken so that the liquid swept over every part of the interior. The greater portion of the liquid was then poured out and the bottle instantly re-corked. In the meanwhile a funnel provided with a plug was procured and the interior of its neck moistened with the solution of potash; it was then placed in the neck of the bottle and wax applied at the junction. This done, almost 300 *grammes* of a solution of Marseilles soap previously rendered clear by means of filtration was poured into the funnel and left there for one hour. At the end of that time the wax was removed and the funnel gradually lifted, the plug being opened simultaneously, and, as the liquid flowed into the bottle the funnel continued to be slowly raised until the extremity of the neck was about on a line with the top of the bottle; the latter was then rapidly corked, some of the liquid remaining in the funnel.

The potash necessarily absorbed the small quantity of carbonic acid contained in the bottle, and at the moment when the funnel was removed no exterior volume of air could possibly penetrate within the bottle, because the stream of liquid flowing in must have expelled much more air than could possibly have found its way in to replace the neck of the funnel. Finally, as merely a portion of the liquid escaped into the bottle, and that at a distance far above the free surface, it could absorb nothing from the superficial layer. Now, with this liquid merely united with air deprived of carbonic acid, transverse waves of a very persistent character were easily developed (the bottle measured three and a quarter inches in diameter), which could evidently not have occurred had the liquid been without an efficient coating. It is quite impossible, therefore, for me to accept M. Marangoni's explanation. Besides, the effectual coating upon the saponaceous solution does not arise from the evaporation of water; for a fatty liquid like soap-suds, for instance, which produces bubbles in consequence of this consistency, does not evaporate at all, but, on the contrary, attracts the dampness in the air. In order to assure myself that the effectual coating of the saponaceous solution does not proceed from the evaporation of water as M. Marangoni thinks it does, I added two parts of Price's glycerine to three parts of the solution, about the proportions generally used to produce a liquid glycerine, and the two substances were thoroughly mixed together. This compound, in consequence of the glycerine, should absorb moisture instead of losing it; now, by means of a pipe it produced bubbles at least two inches and a half in diameter. I then increased the quantity of glycerine, so that the two substances were about equally divided, and even then bubbles two inches in diameter were obtained. Thus, the effectual coating of the solution is not due to the loss of water by evaporation.

As to the solution of albumen, inasmuch as its properties are analagous with those of the soapy solution, although less pronounced, I considered it useless to make the same experiments in reference to it.

Now, if the cause which originates the formation of the effectual coating upon the saponaceous solution is due neither to the action of carbonic acid contained in the air, nor to the evaporation of water, whence does it arise? Must we have recourse to Dupré's somewhat unacceptable idea, which holds that in certain solutions the substance dissolved rises abundantly to the surface? Is it not much easier to admit, as I do, that the superficial coating of liquids forms itself spontaneously into a particular condition, which results in a greater or less difficulty in regard to the relative displacement of the molecules than could occur in the interior of the mass? Does not the fact that tension exists suffice to show that this coating possesses an especial character in reference to the action of molecules?

The experiment which originated Dupré's singular idea mentioned above, is based upon the fact that the height of a fine stream of liquid precipitated from a certain distance must be considerably diminished by the tension of its surface, and Dupré, therefore, concludes that in a little stream of soap-suds the tension is sensibly identical with that of pure water, while we all know that when a solution of soap is in a state of repose its tension does not approach that of water by two-thirds. Dupré concludes that in the stream of saponaceous solution, where the surface is constantly renewed, the soap itself has no opportunity of coming to the outside. But in my theory—a remarkable fact which I have myself confirmed by an entirely different process which it is useless to refer to here—proves that the superficial coating of liquids requires a certain amount of time, however short, to assume its proper atomical condition.

"But," says M. Marangoni, "the superficial coating of the saponaceous solution has no extraordinary viscidity; on the contrary, it is very susceptible of motion." I acknowledge that it does in fact possess great mobility, which proceeds from the extreme thinness of its consistency. Also, it is capable in itself of making but slight resistance towards the movements of the magnetized needle. Still, as it adheres in its fullest capacity to the underlying liquid, and should therefore attract a certain amount of the latter as it rotates, a greater part of the resistance must necessarily be due to this fact. Moreover, we observe, nothing goes to show us that the superficial layer, although very mobile, is less so than the underlying liquid if both are of an equal consistency. We can reasonably admit this after an experiment with the magnetized needle placed within the liquid. Indeed, as the number of oscillations performed by M. Marangoni's needle when in the liquid and when removed from it were respectively five to six, the governing powers of the needle in these two conditions are in proportion to the square of the above numbers, as, for instance, thirty-six to twenty-five, or about three to two. The resistance of the liquid robs the needle of nearly one-third of its governing force; only as we require which part the two superficial coatings play in this resistance, nothing prevents us from attributing it to the principal one of them.

Finally, the resistance in regard to the displacing of molecules cannot be denied as far as the superficial layer of saponaceous solutions is concerned, consequently we should admit this fact, although in a much less degree, in reference to solutions of soap itself. In one of my papers, and also in paragraph two hundred and seventy-eight of my book, I have described a certain number of facts which prove the rigidity existing in the effectual elevating of the saponaceous solution. I will confine myself to one of them as follows:

A bubble about an inch and a half in diameter is blown and placed upon the surface of the liquid; now, holding the mouth of the pipe in close contact with the hemisphere into which the bubble is transformed, you blow gently, increasing its dimensions until it bursts. The spray immediately spreads itself upon the liquid in several parts, each, however, being separated from the surface by a small quantity of air, and gradually disappears as though sinking into the mass, the contraction occupying several seconds.[1]

M. Marangoni, although maintaining perfect silence in

[1] In order to make this experiment successful, it is necessary to use a perfectly pure solution.

regard to this powerful viscidity, relates several experiments which make the fact of its existence very perceptible. Let us quote the following which is merely the continuation of one I have already drawn attention to:

A bubble is blown from a moderately wide tube which, however, has a broad mouth, and the other end is then left perfectly free. The bubble decreases gradually in size, but not in a perfectly systematic manner. On the contrary it elongates and at the same time contracts transversely, assuming a series of longitudinal folds or wrinkles. M. Marangoni explains this fact by stating that owing to the diminution of the surface, the coating of dirt becomes supersaturated and consequently the tension is annulled or reduced almost to nothing, inasmuch as the thin layer forming the bubble thus wrinkled and of a nearly conical shape does not show any tendency towards the minimum of the surface. But, he adds, if the unoccupied end of the tube should be corked so that the bubble would not decrease in size, the form of the latter would grow gradually round, and at the same time it would expel from the bottom certain drops of frosty moisture which forms in the little folds or wrinkles we have already mentioned; then the coating of dirt would resume its normal condition, and the bubble assume, once more, a spherical shape.

M. Marangoni supposes that apart from the wrinkles on the bubble, the tension is utterly null or very nearly so: Now, the existence of any liquid utterly devoid of tension would be very extraordinary and we may say hardly probable. Moreover, the drops of moisture in the interior of the bubble, being the liquid which constitutes the outer coating of dirt, should possess little or no tension. I have collected these drops upon the crystal of my watch, and after repeating the experiment a number of times, I finally procured enough of the liquid to attempt the formation of bubbles by means of it. (I must state here that these drops were purely liquid and not at all frothy like those M. Marangoni describes.) Now, bubbles were formed from this liquid, some of them extending three inches in diameter, that is to say, they were similar in proportion to those obtained by means of the saponaceous solution; only, with the liquid collected from the drops in the crystal, this maximum was much more difficult to reach. In a word, I modified M. Marangoni's experiment in a manner calculated to render his explanation of it still more improbable. A bubble about two inches in diameter was blown from the pipe and the drop suspended from the bottom removed; then, inasmuch as the tube was expressly narrow, the wrinkled and cone shaped form was produced by inhaling through it, and before the drop produced at the extreme point of the cone could fall, the pipe was turned upside down in such a way that the liquid forming the drop ran along the surface of the bubble and separated itself as much as possible on the exterior. Now, although the superficial coating thus conserves very nearly its former consistency, and as consequently (according to M. Marangoni), the tension becomes, so to speak, annulled, the bubble instantly resumed its spherical shape while the pipe was being turned upside down, the time thus occupied not being more than one second. This experiment was repeated several times and always with the same result.

In my opinion these facts can be explained very simply. When you breathe through the pipe, should it be moderately wide or even narrow, the bubble necessarily contracts. It consequently becomes of a thicker consistency and a surplus amount of liquid flows towards the lower extremity; but the strong viscidity of the superficial coatings renders the general augmentation of density, and the equal contraction on all sides, very difficult during the short interval of reduction. The surface wrinkles in very much such a manner as a small bladder would should the air within it be inhaled, and at the same time it elongates into a conical form from the weight of the liquid which accumulates at the bottom. Nevertheless, this liquid arising from the increased density of the bubble does not notably diminish the tension, as is shown by the fact that when the pipe is held upside down and the liquid rests upon the bubble sitelf, the latter regains its spherical form immediately.

In regard to the superficial coating of the solution of soap, M. Marangoni observed that if this coating was viscous it should wrinkle when before the needle, which, however, does not occur at all. In order to discover what really takes place in reference to this circumstance, I began the experiment once more by sprinkling the surface of the solution with pollen[1] just before liberating the needle. If attention is then drawn to the tension of the needle, it will be seen that on the side toward which this half advances, and until a moderate distance is reached, the dispersion of the pollen is diminished, while on the opposite side—that is to say, behind this particular half—it is considerably increased. Thus, the superficial coating in front of the needle, instead of puckering, contracts, and dilates behind it. Now, if we reason in accordance with my theory, and consequently do not admit the existence of a coating of dirt, we should acknowledge that in the portion constructed the molecules pertaining to the superficial coating have left it and entered the interior of the mass, and also that in the dilated portion the molecules belonging to the interior have annexed themselves to the superficial coating in order to maintain the density; these two effects could not be produced, moreover, unless a certain amount of resistance existed. They have necessarily developed also a difference of tension; but, in the second of the two series of estimates which I effected in reference to the duration of the needle's movements on the surface and in the interior of the solution, the temperature was about 21°, and from M. Marangoni's observations upon the spherical cavities before mentioned, it follows that at this degree of temperature the differences of tension should possess but slight influence. However, the ratio concerning the duration of these movements upon the surface and beneath it have been found to about equal 1-78. Besides, these experiments seemed to result in showing that the effect arising from the difference of tension is not altogether to be overlooked, for in the first series in question when the temperature was but 18°, the ratio of duration was somewhat increased; that is to say, about 1-87.

At the beginning of these remarks it was seen that M. Marangoni explains the retarded motion of the needle upon the solution of soap by the difference existing between the tension of the dirty coating and that of the liquid beneath. We have also seen that in regard to liquids such as water, saline solutions, etc., which also retard the needle's movements, he seemed somewhat embarrassed. At the commencement of his work, he insists upon the capillary action of the meniscus, then further on, he appears to attach but little importance to it, and invokes a small quantity of dirt; further on still, he takes refuge in M. Van der Mensbrugghe's theory.

As far as the capillary action of the meniscus is concerned, I have endeavored to make it thoroughly understood that if we admit it at all, we should consider it as being probable the very reverse of what M. Marangoni supposes. He knows, moreover, that the action of a meniscus would not be sufficient in itself to satisfactorily explain the existence of any phenomena; for example, it could not account for the rotation of the entire surface of the liquid. M. Marangoni, therefore, only ascribes a partial *rôle* to it, and at the same time seeks protection under a coating of dirt and the ideas expressed by M. Van der Mensbrugghe. But, you will ask, where then does this coating of dirt come from? Does it arise from particles of dust floating about in the atmosphere? In his first work M. Marangoni says that water which has

[1] In order to do this, the pollen must be spread upon the surface of the liquid by means of a small paper tube held at a certain distance above the solution. Care must be taken to do this as quickly as possible, as the soap moistens the particles and causes them to sink rapidly.

been distilled several times can remain exposed to the air for six or eight days without the slightest augmentation of resistance, in regard to the needle, being apparent. Besides, in the measures taken with distilled water, the entire preparation of the experiment from the moment when the liquid was poured into the capsule until the needle, was left to itself, occupied but five minutes; then during the ten partial measures afterward effected, no increase of resistance was observable. Could particles of dust floating about in the atmosphere produce an effect during those five minutes? Is it admissible? Indeed, M. Hagen has shown us conclusively that the superficial tension of distilled water decreases perceptibly when the liquid is exposed to the air; but this diminution is gradual and continued, and in order to produce any visible effect requires several hours The peculiar fact M. Hagen describes, therefore, appears to me to bear no relation whatever to the resistance shown to the needle's movements; and inasmuch as air on the other hand, exercises no chemical action upon distilled water, and moreover as we are unable to invoke the influence of particles of atmospherical dust, we are led to attribute the fact established by M. Hagen to a cause arising from the interior of the liquid.

Now, in reference to the actual state of the case, I shall say again that it is useless to have recourse to a coating of dirt whose existence we cannot account for, and also that it is much more simple to admit the presence of an atomic organization peculiar to the superficial layer of the liquid.

As far as M. Van der Mensbrugghe's theory is concerned, M. Marangoni expresses himself in the following manner:

"The mass of the liquid effectually diminishes the variations of temperature produced upon the surface, which, in its turn, also decreases the variations of tension; in ordinary cases the latter are but trifling when compared with the variations attributed to dirt."

According to this remark, we should believe that the surface of the saponaceous solution, which, M. Marangoni states, possesses an undeniable coating of dirt, resists the movements of the needle more forcibly than the distilled water which could have hardly any dirt on its surface. In my experiments however, directly the opposite of this has occurred. The ratio of time required for the needle to describe an angle on the surface and beneath it when distilled water was used was, 1, 92, while when soap was used it was but 1, 82.

M. Van der Mengsbrugge's theory certainly deserves some attention in regard to the phenomena in question; but owing to the above remark of M. Marangoni, and the considerable dimension of the needle, relatively speaking, we may be permitted to doubt that any notable effect can result from it. Besides, if it did, we should find it again in those liquids of weak tension which do not produce bubbles, that is to say, alcohol, spirits of turpentine, olive oil, etc.; at least we should be able to observe a feeble rotation of the entire surface; now, this is by no means authenticated.

Finally, before attributing these phenomena to any other cause than that of a peculiar viscidity of the outer coating, it would be necessary to refute those arguments which have led me to the conclusion that the superficial coating of liquids possesses more atomic mobility than the interior portion. M. Marangoni is perfectly silent in regard to this part of my work.

After this examination of M. Marangoni's theory however, I consider myself justified in maintaining my opinion; but I forego all ulterior discussions referring to the subject, and leave all those physicists who may be interested in the question, to compare for themselves M. Marangoni's writings with mine, and to try to discover, if possible, which of us is right.

## ON THE STRUCTURE OF THE ORANG OUTANG.

By Henry C. Chapman, M. D.

From the paper on this subject in the Proceedings of the Academy of Natural Sciences, of Philadelphia, we take the following facts:

The subject dissected was a young male Orang Outang (*Simia Satyrus*), about three years old. The first thing to strike Dr. Chapman was the length of the upper extremity, it being three inches longer than the lower one, agreeing nearly in this respect with the Gorilla, the difference in the extremities of that animal being $3\frac{1}{2}$ inches, whereas in the Chimpanzee a difference of $1\frac{3}{4}$ inches only was found. The foot in the Orang, however, was $\frac{1}{2}$ inch larger than the hand, whereas in the Gorilla the hand was $\frac{1}{2}$ inch larger than the foot; in the Chimpanzee the difference in this respect was $\frac{3}{8}$-in. in favor of the foot. Indeed, the distinctness of hand and foot superficially is more marked in the Gorilla than in the other anthropoids. The same facial muscles are found in man and the Orang Outang, with the exception that there is but one zygomaticus, possibly corresponding to the zygomaticus minor of man. The facial muscles, however, are not differentiated as in man, rather hanging together. The upper extremity of the Orang, in its muscles, differed essentially from that of man in the absence of the flexor longus pollicis, and extensor primi internodii pollicis and in the presence of the additional tendons to the ring and middle fingers.

The Orang agreed with the Gorilla in not having a flexor longus pollicis, but disagreed with it in having the pronator radii teres, arising by two heads in the presence of a palmaris longus, in the additional tendons for ring and middle fingers, and in not having the extensor primi internodii pollicis.

As compared with the Chimpanzee, the Orang agreed in reference to the pronator radii teres and palmaris longus, but in the absence of the flexor longus pollicis as a slip from the profundus, and in the presence of the additional extensor tendons it differed.

Dr. Chapman differed from Bischoff, Owen, Huxley and others, in seeing no essential difference between the *scansorius*, of Traill, and the glutæus minimus in man, an opinion, it appears, which had been previously expressed by Prof. Barnard in 1876.

The leg and the foot of the Orang, as compared with man, differed in the absence of the peroneus tertius, plantaris, flexor longus hallucis and transversus pedis, in the fibular origin of the soleus, and in the presence of the external origin of the accessorius only, in the distribution of the perforating and perforated tendons of the toes, in the interossei, and in the presence of an opponens for the big toe. In this latter respect, the Orang differs not only from man, but from all the other monkeys and anthropoids, the foot having a very hand-like appearance, as compared with that of the Gorilla and Chimpanzee. The foot of the Orang differs further in the absence of a special flexor for the big toe. This is supplemented, to a certain extent, by the opponens, and in a partly developed accessorius.

If Professor Huxley's canon can be accepted that the distinction between a hand and a foot consists in the latter possessing tarsal bones, the peroneus longus and brevis, the short extensor and short flexor muscles, then the posterior extremity of the Orang terminates in a foot.

Dr. Chapman, however, appeared to think that the difference between the hand and the foot in Man, the Gorilla, and Chimpanzee, and the lower monkeys, is greater than that observed between the corresponding members of the Orang.

It is usually stated that the uvula is absent in the Orang, and on looking into the mouth, at first sight this appears to be the case, as it does not hang down as in man, between the pillars of the fauces. Nevertheless, Dr. Chap-

man found it to exist. Professor Bischoff, however, mentions finding the uvula in the Orang.

The stomach of the Orang is not so human in its form as that of either the Gorilla or the Chimpanzee. Nothing peculiar was noticed about the spleen or pancreas.

The quadrate lobe of the liver was absent. In the small intestine five fine specimens of the *Ascaris lumbricoides*, and one in the large, were found, and in the cæcum a *Trichocephalus dispar*, perhaps the first time these entozoa have been found in the same anthropoid. Dr. Chapman did not notice anything special about the heart different from the human.

The brain was examined and described, but as the researches of Dr. Spitzka in this direction have been published in "SCIENCE," we need not here state the peculiarities which exist.

Dr. Chapman draws the following general conclusions respecting what can be inferred from the general organization of the Orang as to its relation to the primates.

The Orang, like man, has twelve ribs, whereas the Gorilla and Chimpanzee have thirteen ; on the other hand the carpal and tarsal bones are nine in number in the Orang, while the Chimpanzee and Gorilla agree with man in having eight. The Chimpanzee and man are alike in this respect, at least the slip from the flexor longus digitorum in the former is functionally a flexor longus. In the absence of a flexor longus hallucis, and in the presence of an opponens hallucis, the Orang differs from man, the anthropoids and all monkeys. The great blood vessels arise from the arch of the aorta in the Gorilla and man in the same way ; the same disposition is usually seen in the chimpanzee, rarely in the Orang. The lungs in the Orang are not divided into lobes as in the Gorilla, Chimpanzee and man. The stomach in the Gorilla and Chimpanzee is human in its form ; in the Orang, however, it is quite different. The peritoneum in the Gorilla, Chimpanzee and Orang is like that of man ; in the lower monkeys it is different. The brain of the Orang in its globular form, in the cerebellum being usually covered by the cerebum, and in the development of the first occipital gyrus, resembles man more than that of the Gorilla and Chimpanzee. On the other hand, the frontal and temporal lobes in the Orang are not as mnch convoluted as in the chimpanzee, and still less than in man, and the Island of Reil is not convoluted at all, at least in the Orang here described. It will be seen that from the above illustrations, of which many others might be given, that the gorilla and man, in some respects, agree with and differ from the Chimpanzee and Orang, while from other points of view the Orang approaches man more closely than either the Gorilla or Chimpanzee, and that as regards certain muscles, man and the lower monkeys agree in having them, while they are absent in the anthropoids.

From these facts we may reasonably infer that the ancestral form of man was intermediate in character as compared with the living anthropoids or lower monkeys, agreeing with them in some respects, and differing from them in others. The Orang is closely allied to the Gibbons, the Chimpanzee to the Macaques, and the gap between these and the *Semnopithecus* is bridged over by the *Mesopithecus* of Gaudry. Until, however, the paleontologist will have procured more material like that from Pikermi, and interpreted it as ably, it seems to Dr Chapman premature to offer any detailed genealogical tree of the Primates.

Mr. A. D. Anderson, author of "The Silver Country or The Great South-West," has prepared a brief narrative of all efforts since the time of Cortez to effect interoceanic transit across the Isthmus of Tehuantepec. The book will be published at once by Messrs. A. S. Barnes & Co., of New York.

## ON THE ORIGIN OF ANTHRACITE.*

By T. Sterry Hunt, LL.D., F.R.S.

From my comparative studies of carbonaceous minerals I, as long ago as 1861, reached the conclusion that petroleum and anthracite form the extremes of a series, all of which may have been derived from organic matters, by natural processes at ordinary temperatures.†

To this is opposed the ordinary view that anthracite, on the one hand, and petroleum on the other, result from the action of heat on matters of intermediate composition, the one being a distillate and the other a residuum. Late geological studies, however, show that such an hypothesis is untenable for petroleum, and the author, while not denying that a local coking of bituminous coals must naturally result from the proximity of igneous rocks, has long taught that it is equally so for our anthracite fields. The prevalent notion has hitherto been that the difference between these and the bituminous coals farther West is in some way connected with the mechanical disturbance of the strata in the former region ; but to this is opposed the fact that, while the undisturbed coals of Arkansas are anthracite, the highly disturbed coals of northeastern America, Belgium, and other regions are bituminous.

These considerations I have for many years presented to my classes in Geology, and have maintained that the change which results in the conversion of organic matters into anthracite was effected before the disturbance of the strata ; that the hydrogen was removed, as ordinary vegetable decay, in the forms of water and marsh-gas ; and that differences in aeration during the process of change and consolidation of the carboniferous vegetation are adequate to explain the chemical differences between anthracite and bituminous coals.

Prof. J. V. Lesley, to whom I have explained my views, has pointed out that there is an apparent connection in the great Appalachian coal-basin, between the more or less arenaceous and permeable nature of the enclosing sediments and the more or less complete anthracitic character of the coal, while Principal Dawson informs me that he has observed similar facts in the coal-measures of northeastern America. Inquiries which promise to throw farther light on this question are in progress, and the present note to the Academy is to be considered as only preliminary to a farther discussion of the subject.

## NIMRAVIDÆ AND MIOCENE CANIDAE.*

Prof. Edward D. Cope.

The *Nimravidæ* is a new group resembling the cats, but differing fromthem in the presence of six pairs of foramina which are characteristic of other families of *Carnivora*. They are older than the *Felidæ* occuring in Miocene formations commencing with the lowest horizons. Some of the species are supposed to occur in the upper Eocene. The family includes the primitive cats, the false sabretooths, and the primitive sabre-tooths, which correspond respectively with the true cats, and the true sabre-tooths, forming heterologous terms of two homologous divisions.

The genera of Miocene *Canidæ* in North America are *Amphicyon Tennocyon*, and *Galecynus*, all distinguished by the presence of the epitrochlean foramen. Other genera are *Enhydrocyon* and *Ieticyon*.

* Read before the National Academy of Sciences, N. Y., 1880.

†Canadian Naturalist, July, 1861, and Report Smithsonian Institution for 1862 ; also Chem. and Geol. Essays.

## ON PHOTOGRAPHING THE NEBULA IN ORION.*

By Professor Henry Draper.

The gaseous nebulæ are bodies of interest because they may be regarded as representing an early stage in the genesis of stellar or solar systems. Matter appears to exist in them in a simple form, as indicated by their simple spectrum of three or four lines. It is desirable, therefore, to ascertain what changes occur in the nebulæ, and determine, if possible, the laws regulating their internal movements. Drawings by hand have been made of some of the nebulæ, and especially of the nebula in Orion, for upwards of 200 years. But drawings are open to the objection that fancy or bias may distort the picture, and it is therefore difficult to depend on the result, and to compare the drawing of one man with that of another. To apply photography to depicting the nebulæ is difficult, because these bodies are very faint, and, of course, owing to the earth's motion and other causes they seem not to be at rest. They require a large telescope of special construction, and it must be driven by clock-work with the greatest precision. All such difficulties as those arising from refraction, flexure of the telescope tube, slip of loose bearings, atmospheric tremor, wind, irregularities of clock-work, foggy or yellow state of the air, have to be encountered. The photographic exposure needed is nearly an hour, and a slip or movement of a very small fraction of an inch is easily seen in the photograph when it is subjected to a magnifier.

The means I have used to obtain the picture are as follows: A triple achromatic objective of 11 inches aperture made by Clark & Sons, according to the plan of Mr. Rutherford, for correcting the rays especially for photography. This telescope is mounted on an equatorial stand and driven by a clock that I made myself. The photographic plates are gelatino-bromide, and are about eight times as sensitive as the wet collodion formerly employed.

As to the picture itself the nebula is very distinct in its bright portions. The stars of the *Trapezium* and some others are so greatly over exposed that under the magnifying power employed they assume a large size, partly from atmospheric tremor and partly from other causes. It is probable that much more of the nebula will be obtained in pictures taken in the clear winter weather. This photograph was made at the end of September when there was some fog in the air; but nevertheless, the original shows traces of the outlying streamers seen in the drawings of other observers. A series of photographs taken at various times of the winter season and in different years will give us the means of determining with some precision what changes, if any, are taking place in this body.

## ELECTRO-MOTIVE FORCE OF THE BRUSH DYNAMO-ELECTRIC MACHINE.*

Professor Henry Morton.

Some recent experiments, which I made in determining the electro-motive force of the Brush dynamo-electric machine, and various instruments for the accurate measurement of electric currents of great strength, show that each pair of coils on the armature of the machine develops a fluctuating electro-motive force, the projection of which gives a kind of oval curve around the centre of a diagram.

When these curves for each pair of coils are combined, it is found, that they show a kind of eight-lobed figure with intersecting lines in certain places. These intersections, if compared with the positions of the commutator, are found to coincide exactly with the points at which rupture of circuit occurs, and thus show that each pair of coils is thrown out, not at the point where its force is least, but at that at which its electro-motive force is equal to that from which it breaks; thus suppressing a spark, but only at a certain sacrifice of theoretical efficiency.

* Read before the National Academy of Sciences, N. Y., 1880.

## APPLICATION OF THE PHOTOPHONE TO THE STUDY OF THE NOISES TAKING PLACE ON THE SURFACE OF THE SUN.

On visiting the Observatory of Meudon, at the invitation of M. Janssen, Mr. Graham Bell examined with much care the large photographs which are being made there for the study of the solar surface. M. Janssen having informed him that he detected movements of a prodigious rapidity in the photospheric matter, Mr. Bell had the idea of employing the photophone for the reproduction of the sounds which these movements must necessarily produce on the surface of the sun. M. Janssen approved of the idea, and requested Mr. Bell to attempt its realization at Meudon, placing all the instruments of the observatory at his disposal. The weather being very fine on Saturday last (October 30), Mr. Bell came to Meudon to attempt the experiment. A large solar image of 0.65 metre in diameter was examined with the selenium cylinder. The phenomena were not sufficiently decided to be regarded as successful, but Mr. Bell does not despair of succeeding on further examination. M. Janssen suggested that the chance of success would be much greater if in place of directly interrogating the solar image where the variations are produced, though responding to considerable changes on the sun's surface, are not sufficiently rapid even in the most powerful instruments to cause the production of sounds in the photophone, a series of solar photographs of one and the same spot, taken at sufficient intervals to obtain well-marked variations in the condition of the spot, might be passed with a suitable rapidity before an object glass, which would give conjugated images upon the selenium apparatus. This would be a means of condensing into a time as brief as could be desired the variations which in solar images are much too slow to give rise to a sound. M. Janssen has placed himself at Mr. Bell's disposal to provide him with solar photographs suitable for carrying out this idea, and the latter has sent M. Janssen the photophonic apparatus requisite. It has appeared to M. Janssen that the idea of reproducing on earth the sounds caused by great phenomena on the surface of the sun was so important that the author's priority should be at once secured.

## LECTURE PHOTOPHONE.

A simple form of Photophone, which is sufficient to show the principle of the instrument, and may be used for lecture purposes, has been arranged by Mr. Shelford Bidwell, and exhibited before the Physical Society of London.

The reflector for receiving the light is discarded, and the beam focussed on the selenium by the lens.

The two lenses used cost only about six dollars, and the beam is sent fourteen feet.

The selenium cell was made by spreading melted selenium over sheets of mica, and then crystallized by heat. For mica Professor Bell recommended microscopic glass.

The resistance of the cell was 14000 ohms in the dark and 6500 in the light. Speech was distinctly transmitted by this apparatus.

## ASTRONOMY.

### SWIFT'S COMET.

Swift's periodic comet, which has now become quite faint, was observed on December 10th and 11th, with the 26 in. equatorial of the Naval Observatory, and it is hoped that more observations will be obtained as soon as the moon has passed. On account of an elliptic motion, it has been slowly departing from the ephemer's computed by Mr. Upton with parabolic elements and published in Vol. I, No. 21, of "SCIENCE."

The following is a continuation of Mr. Upton's ephemeris, which he has correc'ed, however, from the most recent observations:

EPHEMERIS.—WASHINGTON MEAN MIDNIGHT.

| DATE. | R. A. | | | DECL. |
|---|---|---|---|---|
| | H. | M. | S. | |
| 1880, December 18 | 5 | 14 | 44 | +38° 5 2′ |
| " " 20 | 5 | 20 | 40 | 36 45 .1 |
| " " 22 | 5 | 25 | 53 | 35 29 .9 |
| " " 24 | 5 | 30 | 35 | 34 19 .6 |
| " " 26 | 5 | 34 | 47 | 33 14 .0 |

A NEW Astronomical Journal, *Urania*, edited by Dr. Ralph Copeland and Mr. J. L. E. Dreyer, is to appear early in January. It will be published in numbers of from 16 to 24 quarto pages, as material can be accumulated. The names of the editors, Mr. Dreyer as a former assistant to Lord Rosse, and Dr. Copeland as Lord Lindsay's assistant, are sufficient assurance that this will meet the want long felt in England and Ireland of a journal, published at frequent intervals, especially devoted to the interests of astronomers.

Lieut. S. E. Tillman, of the Corps of Engineers, whose name is well known in connection with the American Transit of Venus Expedition to Tasmania, has been appointed Professor of Chemistry, Mineralogy and Geology, at West Point, in the place of Professor H. L. Kendrick, who has voluntarily retired in order that this appointment might be made. Professor Tillman has had a very varied experience as an officer of engineers, his duties having led him to astronomical and geodetic work in the field and to geographical and geological explorations. The military academy may be congratulated upon having secured a valuable addition to its present strong academic staff.

The volume of Washington Astronomical Observations for 1876, containing, in an appendix, the reports on the total solar eclipse of 1878, is expected, in a few days, from the Government printing office.

Mr. S. C. Chandler, Jr., publishes in *Science Observer*, a description of an instrument, the "Almacantar," which he has invented for determining time and latitude. The instrument is designed for the observation of "Equal Altitudes," the principle upon which it is made being that of Kater's floating collimator. The Y's, in which the pivots, rest are secured to opposite sides of a hollow iron rectangle which floats in a rectangular basin of mercury. The telescope can be clamped in altitude and the whole instrument rotated about a vertical axis. The float is allowed to seek its level, and thus the telescope will indicate equal altitudes on either side of the meridian. The probable error of a clock correction, as determined from a series of observations with this instrument, is about ± 0.05 sec. W. C. W.

P. S.—For notice of a new comet see page 297.

*To the Editor of* SCIENCE:

I observe what appears to be some errors in dates in the list of minor planets discovered by the late Prof. J. C. Watson, mentioned by your correspondent.

(133) Cyrene was discovered August 14, 1873. (*American Journal of Science*, III., vi, 296).

(174) Phædra was discovered August 8, 1877. (*American Journal of Science*, III., xiv, 325).

(175) Andromache was discovered September 2, 1877. (*American Journal of Science*, III., xiv, 325).

He also discovered, October 20, 1857, the planet observed a few days before by Luther, and since named *Aglaia;* also, October 9, 1865, the planet seen by Peters a few days previously, and since named *Io;* also, July 29, 1873, a planet which on account of cloudy weathe, eluded his subsequent observation. (*American Journal of Science*, III., vi, 296).

A. WINCHELL.

University of Michigan, Ann Harbor, Dec. 11, 1880.

## MICROSCOPY.

In the American Monthly Microscopical Journal for December, Dr. J. J. Woodward claims for Professor J. L. Riddell, M. D. of the United States, the priority in inventing at least two forms of Binocular Microscopes, since introduced by Beck of London, and Nachet of Paris.

This communication of Dr. Woodward appears to prove beyond a doubt that to an American, Dr. Riddell, then of New Orleans, is due the credit of first demonstrating and publishing the optical principle, on which all the most successful binoculars, made prior to the present year, depend. He first showed that the cone of rays proceeding from a single objective may be so divided by means of reflecting prisms, placed as close behind the posterior combination of the objective as possible, that orthoscopic binocular vision can be obtained both with the simple and compound microscope.

While giving full credit to Dr. Riddell for all that is due to him, we think, in justice to Mr. Wenham, the fact should be admitted that he was the first to produce a binocular arrangement for the microscope, so simple and perfect in its form, as to render its general use possible. We once asked a London microscope maker, why the Stephenson form of binocular was only adopted by a very few microscopists, and were informed, in reply, that the expense was great in constructing microscopes on this model, and on that account they were not popular.

As we find from Dr. Woodward's paper that the improved form of Dr. Riddell and that of Stephenson were practically alike, it may be that for this the reason neither received the attention anticipated.

An interesting paper on *Cercaria hyalocanda*, by Herman C. Evarts, may be found in the same Journal. This larval form of a trematode was observed to come from the common pond snail (*Physa heterostropha*) when placed in a shallow dish containing water.

In form, the body when contracted was globular, and this form was maintained by the animal while actively swimming about; at rest it would extend its tail, and then assume a somewhat triangular form.

They were sufficiently large to be seen by the naked eye, and were observed to encyst themselves, contracting during the process to a globular form, around which was secreted a glutinous mass. A few seconds after the cyst commenced to form, the tail detached itself and swam away.

We are also indebted to this journal, for the description of the following method of mounting opaque objects, contributed by Mr. A. H. Chester:—

"The object is first fastened to the slide, which is centered on the turn-table, by means of a weak solution of gelatin,

gum water, or Brunswick black. For very small objects a small circle of the gelatin is turned in the centre of the slide, and then allowed to dry. The objects are arranged on the spot, and then, by carefully breathing on the slide, they are fixed in position. If larger objects are to be fixed to the slide a spot of gelatin or gum that the object will entirely cover is put on, and after drying, the object is fixed in the same way. For larger and heavier objects a circle of Brunswick black is turned, and after it has been thoroughly hardened by heat, so that when cool a needle point will not mark it easily, the object is arranged on the spot and fastened by warming again.

In whatever way the object is fastened, the next thing to be done is to lay the slide on the plate and heat it until it is perfectly dried and ready to be covered.

The slide is then centered on the table and a circle of shellac, which has been thickened and colored with Chinese vermillion, is run around the specimen, at such a distance from it that its inner edge is just larger than the cell to be used. The cell is then laid on, centered, and pressed hard to set it. If the slide is slightly warm and the cement thick, it will not run at all, but will hold the cell firmly in place, so that the cover can be put on at once. If it is thin it must first be allowed to harden somewhat. When ready, as it will be in a few moments if properly managed, a ring of the same cement is run on the cell and the cover is then laid on, pressed down, clipped in position, and the mount laid aside to harden. It is well in an hour or so to remove the clip and run cement in the joints between cover-glass cell and slide, in order to be certain that no air-holes remain. It can then be reclipped, and set aside until the cement is perfectly hard. The mount is complete and will last a long time if proper care is taken of it. I think for security it is well to put on additional rings of cement more elastic than the shellac, and to make a final finish for the sake of appearance. I, therefore, put on a ring of white zinc cement which completely fills up the joints, and makes a smooth surface from cover-glass to slide. This must harden several days, and the slide is then complete, unless additional rings are run on for a finish.

In making the rings on slides it is not always easy to make the edges true, and sometimes the cement spreads too far. In such cases I turn them down with the point of a knife until they suit. If the cement is taken just at the right time this is easily done, and it improves the appearance very much."

## BOTANY.

THE COLOR OF FLOWERS.—At a recent meeting of the Vaudois Society of Natural Science, Prof. Schnetzler read an interesting paper on the color of flowers. Hitherto it has generally been supposed that the various colors observed in plants were due to so many different matters—each color being a different chemical combination without relation to the others. Now, however, Prof. Schnetzler shows by experiment that when the color of a flower has been isolated by putting it in alcohol, one may, by adding an acid or an alkali, obtain all the colors which plants exhibit. Plants of Pæony, for example, yield, when macerated in alcohol, a violet-red liquid. If some acid oxalate of potassa be added, the liquid becomes pure red; while soda changes it, according to the proportion used, into violet, blue or green. In the latter case, the green liquid appears red by transmitted light, just as a solution of chlorophyll does. The sepals of Pæony, which are green bordered with red, become wholly red when placed in a solution of acid oxalate (binoxalate) of potassa. These changes of color, which may be obtained at will, may quite well be produced in the plant by the same causes; since, in all plants, there always exist acid or alkaline matters. Further, it is stated that the transformation from green into red, observed in the leaves of many plants in autumn, is due to the action of the tannin which they contain, on the chlorophyll. Thus, without desiring to affirm it absolutely, Prof. Schnetzler supposes, *a priori*, that there is in plants only one coloring matter—*chlorophyll*, which, being modified by certain agents, furnishes all the tints that flowers and leaves exhibit. As for white flowers, it is well known that their cells are filled with a colorless fluid, opacity being due to air contained in the numerous lacunæ of the petals. On placing the latter under the receiver of an air-pump, they are seen to lose their opacity and to become transparent as the air escapes from them.

PROFESSOR W. W. Bailey, of Brown University, states that the herbarium of the late Col. Stephen T. Olney, of Providence, R. I., was left by his will to Brown University, on condition that it be placed in a fire-proof building. It is probably known to the readers of "SCIENCE" that Col. Olney was an invalid and incapacitated for business during the last years of his life. At that time the herbarium, which had been stored in Butler Exchange, was transferred by the trustees to the fire-proof library building of Brown University, the only edifice possessed by the college which would fulfil the requirements. Professor Bailey was requested to examine and arrange the collections, which he did in connection with Mr. James L. Bennett. He is greatly indebted to this gentleman for valuable suggestions and assistance which his natural neatness of method and mature experience rendered easily possible. He it was who arranged the *Carices* (which were Col. Olney's specialty), together with the lower Cryptogams, many of which he had himself collected.

They found this elegant herbarium, one hardly surpassed by any private collection in America, badly injured by insects. The first work, then, was to poison what could be saved. It is not an exaggeration to say that one-third of the Phanerogams had suffered. In places a whole genus would be riddled by the *Anthrenus*. It was a sad sight; for the specimens had been prime, were superbly mounted, and many of them impossible to replace. Col. Olney was so neat in his methods that he disliked to see a blemish on any paper; hence his very sense of order was perhaps a means of loss. Every plant had to be thoroughly poisoned. Now that the college has come into possession, it will be necessary to throw out mutilated specimens and replace them by others. Mr. Bennett and Professor Bailey stand ready to fill the vacancies from their own herbariums.

The collection is a fine one in every way. In Rhode Island plants it is only equalled by that of Mr. Bennett. It is very rich in Southern and Western plants of Hale, Chapman, Curtis, Ravenel, Fendler, Parry, Thurber and many other well-known collectors. There is a fine set of Wright's Cuban plants, of Robin's *Potamogetons*, of Sullivant's and Austin's Mosses, etc., etc. Indeed the owner spared no expense (and he was a wealthy man) to build up his herbarium. In the genus *Carex* it must long remain unique and classic. There is much raw material and many duplicates in *Carex*. As Colonel Olney's correspondence shows him to have been in debt as regards exchanges, Professor Bailey, who now has charge of the herbarium, would be pleased to communicate with such botanists as have not received returns. He will then, acting under the direction of the college authorities, endeavor to discharge all such obligations. Col. Olney bequeathed a fund of $10,000 for the increase of his herbarium and library. The latter, containing 712 volumes also comes to Brown University, together with his Chevalier and Smith & Beck's microscopes and much valuable apparatus and material. With another $25,000 left by the deceased Colonel, a professorship of Natural History has been created. One of the duties of the professor is to give lectures on Botany.

We are under obligations to the *Bulletin* of the Torrey Botanical Club, for occasional botanical notes. This Journal has now been published for ten years, and was established as a means of communication for botanists. The address of the editor is, W. H. Leggett, 54 East 81st street, New York City. The rates are one dollar per annum, so that its cost will hardly be a bar to its use by botanists. We can probably arrange club rates for our subscribers.

## CHEMICAL NOTES.

Adulterations of Saffron.—Saffron is sophisticated with muscular fibre, the flowers of *Calendula officinalis*, safflower, *Crocus vernus*, *Punica granatum*, fragments of sanders-wood, glucose, glycerin, oil, chalk and heavy-spar.

Preparation of Ashes Destined for the Extraction of Iodine from Sea-weeds.—The most advantageous weeds for this purpose are the two varieties of *Fucus digitatus*. Dr. Thiercelin states that he has succeeded in extracting from the plant 3 per cent. of iodine.

Manufacture of Phosphoric Acid.—Natural phosphates, unground, are dissolved in dilute hydrochloric acid. When the acid has ceased to act the clear solution is run off from the insoluble matters and mixed with sulphuric acid enough to saturate all the dissolved lime, leaving a mixture of hydrochloric acid, dilute phosphoric acid, and calcium sulphate. This mixture is submitted to pressure to separate the sulphate from the free acids, which are then concentrated, and the hydrochloric acid is condensed and collected for use by means of ordinary columns.—M. A. Colson.

Complex Acids Containing Boric Acid.—Dr. F. Mauri has formed boro-tungstic acid by dissolving tungstic anhydride in a solution of borax, and continuing to add the former until the liquid is no longer rendered turbid bd hydrochloric acid. He is engaged with the formation any the study of the boro-molybdic acid and its salts

Compound of Titanium Tetra-chloride and of Phosphorus Proto-Chloride.—The composition of this compound is represented by the formula $TiCl_4PCl_3$.—M. Armand Bertrand.

Compound of Titanium Tetra-chloride and Ethyl Oxide.—If the vapors of these two bodies are brought in contact, fine crystals of a greenish yellow color are produced.—M. Armand Bertrand.

Reduction of Ethyl Nitrate by Alcohol.—Nascent ethyl nitrate is reduced in presence of alcohol, yielding ethyl nitrite and aldehyde.—M. Armand Bertrand.

Products Contained in the Coke of Petroleum.—Experiment shows that the accumulation of the carbon is effected with an increasing rapidity, and the weight of the molecule rises to a limit still little known, but which can be no other than the formation of insoluble bodies whose richness in carbon is equal or even inferior to that of the bodies which have remained soluble. We reach thus, by a progression easy to conceive, the term of the series which must equally include crystalline bodies such as graphite and diamond. It is known, on the other hand, that the higher polymers, when submitted to very high temperatures, seem to depolymerise themselves (as happens with metastyrolene), yielding gaseous carbon compounds.—MM. L. Prunier and Eug. Vareune.

Action of Mono-bromated Diphenyl-methan upon Ammonia.—If the ammonia is in alcoholic solution, ammonium hydro-bromate is deposited; and the alcoholic liquid, if precipitated with water, yields, as a principal product, a mixed ethyl-benzhydrolic ether. Concentrated aqueous ammonia acts differently; the crystalline bromine is gradually transformed, and in twenty-four hours the mass becomes liquid. In forty-eight hours more it becomes solid, and then it no longer contains bromated diphenyl-methan.—MM. C. Friedel and M. Balsohn.

Synthesis of Chinoline.—The alizarin blue of Prud'homme has the composition $C_{17}H_9NO_4$, and is probably a dihydroxylised quinon of anthrachinoline. It is formed from nitro-alizarin and glycerin, with the elimination of water. Chinoline is actually obtained on heating together nitro-benzol, glycerin, and sulphuric acid.—Z. H. Skraup, *Wiener Anzeiger*, 1880, 69.

Function of Lime in the Life of Plants.—E. v. Raumer and Ch. Kellermann assert that lime is absolutely necessary for the life of plants, and its function is most closely connected with the utilization of the carbohydrates.

Chemicl Investigations in the Bohemian Central Mountains.—J. Stocklasa has recently made an examination of the marls and clays of Priesen.—*Listy Chem.*, 4, 135.

Bödecker's Method of Detecting Albumen in Urine.—The urine is slightly acidified with acetic acid, and a few drops of a solution of potassium ferrocyanide are added. In presence of even very slight traces of albumen a turbidity at once appears, and in a short time there is deposited a flocculent sediment. The test is exceedingly sensitive.

Chloraluminium used at Cloth Works.—A sample contained 15.49 per cent. $Al_2Cl_6$, 1.13 $Al_2O_3$, 2.59 NaCl, 0.14 $Na_2SO_4$, 80.65 $H_2O$. Apparently formed by decomposing aluminium sulphate with barium chloride. F. Stolba.—*Listy Chem.*, 4, 193.

Crystalline Prussian Blue.—W. Gintl states that if recently precipitated Prussian blue be treated with a moderate excess of hydrochloric acid at a gentle heat, it dissolves to a slightly yellowish liquid, which, on exposure to the air, gradually deposits Prussian blue as a crystalline sediment, which displays a splendid coppery lustre by reflected light. So-called Turnbull's blue dissolves in hydrochloric acid in the same manner as ordinary Prussian blue, and yields similar crystals—a further evidence of the identity of the two compounds.

True Clay in so-called Clay Soils.—A. Funaro has shown that the highest proportion of clay does not exceed 33 per cent.

## PHYSICAL NOTES.

Certain Modifications Undergone by Glass.—J. Salleron often meets with well made thermometers, the indications of which are erroneous to 8° or 10°, or more. Such changes occur at printing ink works, where oils are heated for several days to 270°; in glycerin works, and with rectifiers of benzol. Glass is not merely modified when heated to 300°; it undergoes true deformations at far lower temperatures. Thus the hydrometers used in sugar works, which are often exposed for a considerable time to temperatures of 95°, are affected. After an immersion of some days they are completely modified: their weight decreases, and they become erroneous to the extent of 7° or 8° B.

The Magnetic Apparatus of M. Edard.—Among other electric or magnetic appliances for the treatment of various diseases is mentioned a magnetic sand, which M. Edard imports from the Isle of Bourbon, and which has been subsequently found near Morbihan. Its application is said rapidly to revive diseased plants.

Spectroscopic Studies of the Sun, Conducted at the Observatory of Paris.—L. Thollon asserts that the sun has entered on a period of activity, and he has described and figured certain luminous protuberances, to one of which he ascribes a height of more than 100,000 kilometres.

Dr. J. H. Gladstone read a paper "On the Specific Refraction and Dispersion of Isomeric bodies" before the Physical Society of London. He concluded that the dispersion of a body containing carbon of the higher refraction, is very much greater than that of a body containing carbon of the normal refraction (5), and that isomeric bodies which coincide in specific refraction coincide also in specific dispersion.

Ultra-violet Rays.—J. L. Shönn has ascertained the position of the ultra-violet rays of the spectra of cadmium, zinc, thallium, calcium, indium, magnesium, iron, and aluminium. His apparatus is well adapted for the study of absorption spectra; a column of water of 10 centimetres contained between two plates of quartz absorbs the greater part of the ultra-violet rays, whilst a block of very pure ice of 21 centimetres does not sensibly absorb the rays of cadmium in this portion of the spectrum.

## BOOKS RECEIVED.

ZOOLOGY FOR HIGH SCHOOLS AND COLLEGES, by A. S. Packard, Jr., M.D., Ph.D. Second edition revised. Henry Holt & Company. New York. 1880.

The second edition of Professor Packard's manual of Zoology supplies a want that has been long felt among Naturalists, for a work of convenient size and form on this subject, with ample illustrations judiciously selected.

In compiling his book the author has freely used the larger works of Gegenbaur, Huxley, Peters and Carus, Claus, Rolleston and others, and even paraphrased or adopted the author's language *verbatim* when it suited his purpose.

In order to secure a greater accuracy of statement, and to render the work more authoritative as a manual of Zoology, Professor Packard has submitted the manuscript of certain chapters to naturalists distinguished by their special knowledge of certain groups. Thus the manuscript of the Sponges was read by Professor A. Hyatt; of the Worms and Mollusca, by Dr. Charles S. Minot; of the Echinoderms, by Mr. Walter Faxon; of the Crustaceæ, by Mr. J. S. Kingsley; of Fishes, by Professor T. Gill, whose classification, as given in his "Arrangement of the Families of Fishes," has been closely followed, his definition being often adopted word for word. The manuscript of the Batrachians and Reptiles was read by Professor E. D. Cope; of Birds and Mammals, by Dr. Elliott Coues, U. S. A.

The work being thus the joint production of so many eminent naturalists, it may be considered a thoroughly reliable guide to the advanced student who desires a general review of the animal kingdom, covering the most advanced teachings up to the date of publication.

The illustrations to this work, five hundred and fifty in number, is one of its most attractive features, and the author acknowledges his obligations to the publisher for his liberal co-operation in producing them. A fair proportion are original. We notice that Dr. C. S. Minot has drawn the full-page illustrations of the typical vertebrates, and that Mr. J. S. Kingsley and Professor W. K. Brooks contributed drawings of the nervous system and otocyst of the clam, while acknowledgment is made to Professor F. V. Hayden, Professor S. F. Baird and others for assistance given.

The work is presented in a handsome, large 12 mo. volume of over 700 pages, printed in large type and on excellent paper.

In regard to the manner in which the subject is treated and the general scope of the book, Professor Packard has designed a work to be used quite as much in the laboratory, or with specimens in hand, as in the class-room. He states that if Zoology is to be studied as a mental discipline, or even if the student desires simply to get a genuine knowledge at first hand of the structure of the leading types of animal life, he must examine living animals, watch their movements and habits, and finally dissect them, as well as study their modes of growth before and after leaving the egg or the parent, as the case may be. But the young student in a few weeks' study in the laboratory cannot learn all the principles of the science. Hence he needs a teacher, a guide, or at least a manual of instruction. This work, which is an expansion of a course of lectures for college students, has been prepared also to suit the wants of the general reader who would obtain some idea of the principles of the science as generally accepted by advanced zoologists, in order that he may understand the philosophical discussions and writings relating to modern doctrines of biology, especially the law of evolution and the relations between animals and their surroundings.

Such is the programme of the author of this book, and we congratulate him on the practical and exhaustive manner in which he has carried it out. The inductive method has been selected, and the student is first presented with the facts; is then led to a through study of a few typical forms, taught to compare these with others, and finally led to the principles or inductions growing out of the facts. He is not assailed with a number of definitions or diagnoses applicable to the entire group to which the type may belong before he has learned something about the animals typical of the order or class; but these are placed after a description of one or a few examples of the group to which they may belong. The simplest, most elementary forms are first noticed, beginning with the Protozoa and ending with the Vertebrates, believing that this is the more logical and philosophical method, and that in this way the beginner in the science can better appreciate the gradual unfolding of the lines of animal forms, which converge towards his own species, the flower and synthesis of organic life.

Professor Packard concludes the above explanation of the general plan of the work by advising the student to commence with Chapter VIII., on Vertebrates, and to master, with specimen in hand, the description of a frog, in order that he may have a standard of comparison, a point of departure, from which to survey the lower forms.

The concluding chapters of the work relate to the comparative anatomy of the organs, the development and metamorphoses of animals, the geographical distribution and geological succession of animals, the origin of species, man's place in nature, instinct and reason in animals. These subjects are lightly touched on, and the problems involved sketched in outline only, the author referring the reader to the works of specialists who have given these matters exhaustive consideration.

Professor Packard has been long prominently identified with practical scientific work covering this department of science, and his present work can be accepted without hesitation as an authoritative manual on the subject. We have read this manual of Zoology with peculiar satisfaction, because it is illustrated by our own more familiar natural objects. The first steps of the student of Zoology are plainly set forth, and by the aid of excellent wood engravings and intelligent descriptions, the various forms of life from the lowest to the highest are made clear to his understanding.

We take pleasure in advising students of Zoology to make use of this work as the best guide that can be secured, and the general reader may study it with advantage, for it treats of a subject of interest to us all, and deals with problems of the highest importance to mankind.

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We have received a copy of the Proceedings of the Iowa Academy of Sciences, which covers a report of the work done from its organization in 1875 up to June, 1880.

The President of the Academy is Professor Charles E. Bessey, M. Sc., Ph. D., author of the recently published Manual of Botany, and a Professor in the Iowa Agricultural College.

We recognize among the list of Fellows, many names which are familiar to us, as specialists in various departments of Science, and we regard the Academy as being fortunate in possessing so strong an organization.

At the annual meeting in June last, a series of valuable papers were read, and we regret that the abstracts presented in the report are too brief to enable us to reproduce them with advantage.

We hope to be able to publish later, comprehensive abstracts of papers read before this Academy of Sciences.